Cost Weight Compression: Impact of Cost Data Precision and Completeness

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This study was designed to quantitatively assess the impact of deficiencies in completeness and precision of hospital case cost data on cost weight compression. For the nursing per diem model versus the nursing workload model the average compression was 19.6 percent (for the 25.9 percent of cases that changed cost weight by at least 5 percent). We concluded that the compression of case mix cost weights based on nursing per diem cost or per diem charge models, such as for U.S. diagnosis-related groups (DRGs), may be pervasive and material.

INTRODUCTION

Case mix and associated cost weights are becoming increasingly important factors in the development of new hospital funding methodologies in many countries (Jackson, 2001; Nilsson, 2002; Palmer et al., 1998). The integrity of these new funding methodologies is directly related to the integrity of the case-mix grouper algorithm employed as well as the integrity of the associated relative cost weights. The development of a case-mix grouper and calculation of cost weights is reliant, in turn, on the availability of patient level case cost. A proxy for cost, length of stay, was used to develop the original DRG grouper when case cost data was unavailable. More recently, the development of DRG-associated cost weights was based on a different proxy for case costs, namely, hospital charges. Patient charges, however, even after being adjusted by hospital-specific, department-level, cost-to-charge ratios (Cotterill, Bobula, and Connerton, 1986; Carter and Farley, 1992; Benoit, Skea, and Mitchell, 2000), still represented only a proxy for actual case cost. Ideally, cost weights should be based on a representative sample of actual case cost data from all case-mix assigned groups, rather than on proxies for cost (Price, 1989: Shwartz, Young, and Siegrist, 1995).

Currently, the integrity of U.S. DRG cost weights is an issue that is receiving considerable attention from the Medicare Payment Advisory Commission (MedPAC). A report from MedPAC (2005) to Congress on physician-owned specialty hospitals showed the accuracy of the payment system was identified as a major concern. Consequently, the first MedPAC recommendation was that: "The Congress should improve payment accuracy in the hospital inpatient prospective payment system by: …basing the DRG relative weights on the estimated cost of providing care rather than on charges…".

An all-patient Canadianized version of DRGs, called Case-Mix Groups (CMGs™), was first developed in 1983 by the Canadian Institute for Health Information (CIHI). The CMG™ grouper was originally derived from the U.S. Medicare DRG grouper, but has since been further refined to, among other things, accommodate for differences between the U.S. Medicare population and the Canadian population (e.g., to include all age groups, more discriminate trauma,

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and HIV groups). The basic structure and hierarchy, however, remains largely analogous. Most CMGs™ share the basic grouper logic of DRGs (i.e., based on abstracted diagnosis and procedure codes and birthweight for neonates) and CMGs™ are even largely in the same numerical order as DRGs. However, because CMGs™ are based on *International Classification of Diseases Version 10* (ICD-10) codes whereas DRGs are based on ICD-9 (Centers for Disease Control and Prevention, 2005), a direct code-to-code comparison of the two groupers is not possible. The CMG™ grouper is a proprietary product of CIHI (2003) and the technical specifications are fully described in their CMG™ Directory document.

It should also probably be emphasized here, at the outset, that the current study is predicated on the rationale that greater accuracy and completeness of cost data will impact cost weight (and payment) accuracy in the same fashion, that is, irrespective of any differences in grouper algorithms (such as differences between CMGs™ and DRGs). While it can be conceded that the magnitude of the improvement in cost weight accuracy might differ somewhat, it is also apparent that the more discriminate a grouper is (i.e., the more cells it has), the greater the impact on cost weight accuracy. For an extreme example, consider that a grouper having only a single cell/group with a single cost weight will show no improvement in the cost weight accuracy no matter how accurate (or inaccurate) the cost data is. A grouper with a single cell also represents the extreme example of case-mix compression (also called heterogeneity, which is inherent in all types of risk adjustment and grouper algorithms), but which is distinct from cost weight compression. The latter can be impacted by case cost data accuracy, the former cannot. So, although this current study is based on a Canadian CMG grouper and Canadian hospital costs, we believe any identified impacts on cost weight accuracy will nevertheless have international relevance.

Prior to 2001, Maryland charge data was used by CIHI to calculate national relative cost weights for CMGs™. These CMG™ cost weights are known as resource intensity weights (RIWs™). Since 2001, RIWs have been based on inpatient case cost data from approximately 15 to 20 (depending on the year) Canadian hospitals. (Because Canadian hospitals do not bill patients or the government funding agency, there is no such thing as Canadian charge data.) However, as our understanding of the case cost data expands, it is becoming increasingly clear that not all case cost data is equivalent in its ability to accurately reflect hospitalization cost. Although hospitals in the Province of Ontario all ostensibly employ the same comprehensively documented costing methodology (Ontario Ministry of Health and Ontario Hospital Association, 1999), there is nevertheless significant interhospital variation in completeness and precision of case cost data (Ontario Ministry of Health and Long-Term Care, 2004). In this study of case costs, we refer to completeness as meaning the inclusion of all hospital costs, while precision refers to the specificity of item-level costs (e.g., separate/independent labor and supply allocation base) as well as the specificity of cost allocation to individual patients (e.g., standard versus actual operating room times).

Deficiencies in either completeness or precision can compromise the accuracy of derivative cost weights by causing cost weight compression. Compression, in simple terms, refers to the overestimation of costs of the least-sick patients (or cases) and the underestimation of costs of the most-sick patients. In the U.S., cost weight compression has been studied (Lave, 1985;

Thorpe, Cretin, and Keeler, 1998; Carter and Rogowski, 1992) since the early days of DRGs and the introduction of prospective payment for acute inpatients.

The following retrospective study is designed to quantitatively assess the impact of some common deficiencies in completeness and precision of case cost data on cost weight compression. This has been done by using actual item level patient case cost data and simulating differing degrees of completeness and precision that may be commonly encountered in case costing system implementations.

DATA

Case Cost Data

London Health Sciences Centre (LHSC) is a full-scope academic hospital on three campuses with approximately 800 acute care beds. Our case mix is the most diverse of any acute care hospital in the province and includes everything from multi-organ transplants and specialty trauma cases to normal delivery, pediatric, and acute mental health cases. LHSC also has one of the most complete and precise case costing systems (http://www.lhsc.on.ca/casecost/) in Canada (Sutherland, 2004). Case cost data for the fiscal year April 2002 to March 2003 was used for this study. The case cost data consists of 4,460,491 cost line items from over 120 separate patient service departments (or direct care cost centers).

Clinical Data

The corresponding clinical data consists of 35,862 acute inpatient discharges. To simplify analysis, we removed deaths, transfers, and long stay outlying patients, leaving 29,840 patients for whom we had a complete course of diagnostic evaluation, treatment, and aftercare in an acute care institution. As previously noted, patients were classified using CMGs™.

METHODS

Calculation of LHSC-Normalized Cost Weights

As a basis for comparison, LHSC, hospital-specific relative cost weights were calculated for all CMGs™ using total patient cost (sum of direct plus indirect cost). In order to permit direct comparisons between the various simulated cost allocation models, these cost weights were further normalized to the sum of the total of the national (i.e., RIW) total of cost weights for all 29,840 LHSC cases. These LHSC cost weights (referred to as the original cost weights) are the benchmark against which other versions of cost weights from less complete and less precise costing methodologies have been compared.

Nursing Per Diem Simulation

At LHSC, ward nursing costs are determined on the basis of minute-to-minute patient specific nursing workload data (QuadraMed Corp). Conversely, many case costing systems employ ward specific standard per diem rates to estimate nursing costs (Heurgren, 2000). Similarly, in the U.S., it is also most common to base charges on nursing ward per diems or even on more aggregated (i.e., less precise) hospitalwide routine nursing cost per diems (Carter et al., 2002) (possibly further rounded up to a 24-hour day).

For this simulation the more precise minute-to-minute nursing workload costs were replaced with ward-average per diems that are prorated by length of stay (in minutes) on each ward. Cost weights were recalculated and then compared to the original weights.

Missing Support Department Costs Simulation

The cost of support departments, such as respiratory technology, physiotherapy, social work, electrocardiography (ECG), and electroencephalography (EEG) are often not included in case costing implementations because of the lack of patient specific cost allocation information. The original LHSC cost data in this study includes costs for all support departments.

For this simulation, the costs of the following departments were removed from patient cost records: respiratory technology, physiotherapy, occupational therapy, social work, psychology counseling, speech/language counseling, diet counseling, ECG, echocardiography, EEG, and electromyography (EMG). These departments were specifically selected because they represent departments most commonly excluded in case costing systems implementations. Cost weights were recalculated, normalized (i.e., sum of cost weights are equal for all simulation models) and compared to the original cost weights.

Averaging Operating Room Supply Costs Simulation

Not all case costing system implementations are able to allocate individual high-cost operating room/theater supply items, such as hip and knee prosthesis, cardiac valves, stents, cochlear implants, laparoscopy trays, etc., to individual cases. Many hospital costing systems do not support this level of specificity (Jackson, 2001) and such costs are instead commonly included in average operating room supply cost figures that are distributed to all surgical cases (e.g., on a pro rata surgery time basis). At LHSC, individual high-cost operating room supplies are allocated to the patient.

In this simulation, the LHSC cost weights have been recalculated after rolling all the high-cost items into the average operating room supply costs which were then allocated to individual patients on the basis of actual, case-specific, surgery time (i.e., same basis as the allocation of operating room nursing/labor costs).

Combined Simulation

In this simulation, each of the foregoing cost allocation methodologies for nursing costs, support departments, and high surgical supply items were combined. Nursing workload costs were replaced with nursing per diem costs, support department costs were excluded, and high-cost items were included into the average operating room supply costs. LHSC-specific cost weights were recalculated and compared to the original weights.

RESULTS

Since it is impractical to list complete results for each of the 478 individual CMGs™, an attempt has been made to summarize the results of the various simulations by focussing on those CMGs™ where the cost weights changed by more than 5 percent (plus or minus) from the original (full, comprehensive cost allocation model) LHSC cost weights. For example, Table 1 shows that for the nursing per diem simulation, 22.1 percent of the patient cases were in CMGs™ whose cost weight increased by more than 5 percent compared to the original costing methodology.

These 22.1 percent of discharged cases represent 13.8 percent of weighted cases. The difference in these percentages, as well as the average cost weight of 1.0777 for these cases, also indicates that the nursing per diem model is biased toward increas-

Table 1
Impact of Case Costing Methodology Variation on Cost Weight Compression

Simulation	Cases		Average Cost Weight	Average Change	Maximum Change
	Discharge	Weighted			
			Percent		
Cost Weight Overestimated>5%					
Nursing Per Diem	22.1	13.8	1.0777	8.7	23.0
No Support Departments	27.3	12.6	0.7848	6.6	8.0
Average Operating Room Supply	16.3	11.0	1.1480	7.2	12.3
Combination[1]	56.7	33.2	1.0234	9.7	30.0
Cost Weight Underestimated>5%					
Nursing Per Diem	3.8	7.8	2.9821	-9.4	-14.0
No Support Departments	7.4	13.9	2.7055	-9.6	-39.2
Average Operating Room Supply	5.4	13.9	2.4032	-17.2	-67.5
Combination[1]	10.6	22.8	2.9025	-15.2	-65.0
Absolute Over and Under>5%					Compression
Nursing Per Diem	25.9	21.6	1.3563	8.9	19.6
No Support Departments	34.7	26.5	1.1940	8.0	16.2
Average Operating Room Supply	21.7	24.9	1.4588	11.3	39.6
Combination[1]	67.3	56.0	1.3198	11.6	28.8

[1] This simulation includes nursing costs, hospital support departments, and operating room supply costs.

NOTE: For cases where the cost weight changed by more than 5 percent (plus/minus) from original method.

SOURCE: London Health Sciences Center: Original case cost data.

ing (i.e., overestimating) the cost weight of the lower cost weight CMGs. This overestimation averaged 8.7 percent (for these 22.1 percent of discharged cases), with the maximum being plus 23.0 percent.

The most effected CMGs™ (containing a minimum volume of 25 cases) whose cost weight was overestimated by more than 5 percent in the nursing per diem simulation are shown in Table 2. It is apparent that the nursing per diem costing allocation model results in a 23.0 percent overestimation of the cost weight for CMG™ 114—sore throat (MNRH)[1], whose CIHI cost weight (RIW) is 0.3500.

Table 1 also shows that for the nursing per diem simulation 3.8 percent of the patient cases were in CMGs whose cost weight decreased by more than 5 percent. These discharged cases represent 7.8 percent of weighted cases. The average cost weight for these cases was 2.9821, indicating that the nursing per diem cost allocation model is biased toward decreasing (i.e., underestimating) the cost weight of the higher cost weight (i.e., more complex) CMGs™. This underestimation averaged -9.4 percent (case volume weighted) with the maximum being minus 14.0 percent.

The CMGs with the greatest underestimation of cost weights due to the nursing per diem cost allocation model are shown in Table 2. Most affected was CMG™ 772—(dementia with or without delirium with axis III diagnosis) whose cost weight was underestimated by 14.0 percent.

Table 1 also shows the cumulative effect of the overestimated and underestimated cost weights. For the nursing per diem model, 25.9 percent of total typical inpatient cases (or 21.5 percent of weighted cases with an average cost weight of 1.3563) had an average absolute cost difference of 8.9 percent.

However, the concept of cost weight compression is not concerned with the differences between true and estimated cost weights of individual CMGs™, but rather with the differences between true and estimated distribution, that is, the relativity of cost weights across the entire set of CMGs.

[1] CIHI designates certain CMGs as may not require hospitalization MNRH).

Table 2
Top Case-Mix Groups™ Impacted, by the Nursing Per Diem Simulation

Case-Mix Group™	Description	CIHI RIW	Overestimation of Cost Weight
			Percent
114	SORE THROAT (MNRH)	0.3500	23.0
289	INFLAMMATORY BOWEL DISEASE	0.9825	15.8
115	MISCELLANEOUS ENT DIAGNOSES (MNRH)	0.4756	15.4
325	PANCREAS DISEASES EXCEPT MALIGNANCY	0.9486	14.8
146	ASTHMA	0.5786	14.0
596	MISCELLANEOUS GYNECOLOGICAL DIAGNOSES (MNRH)	0.3326	13.9
766	DEPRESSIVE MOOD DISORDERS W/O ECT W/O AXIS III DIAG	1.6677	13.6
783	PSYCHOACTIVE SUBSTANCE DEPENDENCE	0.6577	13.0
			Underestimation of Cost Weight
501	URINARY DIVERSION AND AUGMENTATION	3.8327	-6.2
661	SPINAL PROCEDURES FOR TRAUMA	3.5381	-6.4
650	TRACHEOSTOMY & GASTROSTOMY PROCEDURES FOR TRAUMA	14.9369	-8.3
660	INTRACRANIAL PROCEDURES FOR TRAUMA	3.8695	-8.3
778	SCHIZOPHRENIA & OTHER PSYCHOTIC DISORD LOS < 6 DAYS	0.4139	-8.6
040	TRACHEOSTOMY AND GASTROSTOMY PROCEDURES	11.8266	-8.8
250	EXTENSIVE GASTROINTESTINAL PROCEDURES	5.3231	-9.5
786	DISRUPTIVE BEHAVIOUR DISORDERS	2.3897	-10.0
771	BIPOLAR MOOD DISORDERS LOS < 6 DAYS	0.4152	-10.9
776	SCHIZOPHRENIA & OTH PSYCHOTIC DISORD W/O ECT W AXIS III DIAG	2.7426	-13.1
772	DEMENTIA WITH OR WITHOUT DELIRIUM WITH AXIS III DIAG	2.6634	-14.0

NOTES: CIHI is the Canadian Institute for Health Information. RIW resource intensity weights.

SOURCE: London Health Sciences Center: Original case cost data.

Table 1 further indicates that the nursing per diem costing model compressed 25.9 percent of all cases by an average of 19.6 percent. (This average compression figure was calculated by taking 8.7 percent of 1.0777 plus 9.4 percent of 2.9821 and dividing by the difference between 1.0777 and 2.9821.)

The results of the other three simulated costing models, no support departments, average operating room supply, and combination, are similarly shown in Table 1, and the most impacted CMGs™ in corresponding Tables 3, 4, and 5.

DISCUSSION

In addition to the quantitative analysis previously mentioned, a face-validity or reasonableness evaluation of these results was also conducted. For example, it can be seen from Table 2 that CMG™ 114—sore throat, CMG™ 115—miscellaneous ENT diagnosis, and CMG™ 146—asthma, represent the types of cases whose cost weights are overestimated by a nursing per diem costing model. Intuitively, this seems reasonable since these types of patients generally require less nursing resources per day than the average patient found on our ENT ward.

Similarly, for CMG™ 772—dementia, CMG™ 776—schizophrenia, and CMG™ 771—bipolar mood disorders, representing the types of cases whose cost weights are underestimated, patients in these groups generally require more daily nursing resources than the average patient on the LHSC mental health ward. Table 2 also shows that other types of mental health patients, such as those in CMG 766—depressive mood disorders, and CMG™ 783—psychoactive substance dependence, require less than average nursing resources. One can also calculate, as a specific example, the compression of CIHI RIW cost weights between CMG™ 772 and CMG™ 783 (=22.8 percent) or CMG™ 772 and CMG™ 766 (=60.1 percent).

Table 3
Top Case-Mix Groups™ Impacted, by Excluding Support Departments Simulation

Case-Mix Group™	Description	CIHI RIW	Overestimation of Cost Weight
			Percent
648	NEONATES WEIGHT > 2500 GM (NORMAL NEWBORN)	0.2107	8.0
646	NEONATES WEIGHT > 2500 GM WITH CAESAREAN DELIVERY	0.3772	7.9
603	REPEAT CAESAREAN DELIVERY	0.9572	7.7
609	VAGINAL DELIVERY WITH COMPLICATING DIAGNOSIS	0.8383	7.5
610	VAGINAL DELIVERY AFTER CAESAREAN DELIVERY (VBAC)	0.7561	7.5
611	VAGINAL DELIVERY	0.7127	7.5
604	CAESAREAN DELIVERY	1.2374	7.3
618	ABORTIVE OUTCOME	0.3406	7.3
601	REPEAT CAESAREAN DELIVERY WITH COMPLICATING DIAGNOSIS	1.2026	7.3
617	ABORTIVE OUTCOME WITH D AND C	0.2976	7.3
			Underestimation of Cost Weight
019	INFECTION EXCEPT VIRAL MENINGITIS	1.7672	-7.9
010	NEOPLASM OF NERVOUS SYSTEM	1.3733	-8.2
017	CRANIAL AND PERIPHERAL NERVE DISEASES	1.8980	-8.7
125	TRACHEOSTOMY	22.1115	-9.1
040	TRACHEOSTOMY AND GASTROSTOMY PROCEDURES	11.8266	-9.6
028	OTHER NERVOUS SYSTEM DIAGNOSES	1.1580	-10.2
786	DISRUPTIVE BEHAVIOUR DISORDERS	2.3897	-10.3
013	SPECIFIC CEREBROVASCULAR DISORDERS EXCEPT TIA	1.7604	-11.7
022	SEIZURE AND HEADACHE	0.6017	-34.1
779	DISSOCIATIVE DISORDERS	0.8079	-39.2

NOTES: CIHI is the Canadian Institute for Health Information. RIW resource intensity weights.

SOURCE: London Health Sciences Center: Original case cost data.

Table 3, shows the CMGs™ most affected by not including support department costs, it can be noted that all the overestimated cases shown are obstetrical or newborn. This result is not unexpected, however, since mothers and normal newborns receive far less, if any, supportive care like physiotherapy, respiratory therapy, ECGs, etc., than the average hospital patient. Conversely, the CMGs™ whose costs are underestimated include CMG™ 779—dissociative disorders (requiring extensive psychology, social work, and occupational therapy resources), and CMG™ 22—seizure and headache and CMG™ 13—stroke (requiring extensive of physiotherapy, speech therapy, and EEG resources). It should also be noted that, while one of the foregoing simulations was based on the complete exclusion of support department costs, it is nevertheless also apparent that similar results would be obtained even if these support costs were universally distributed, on a per case or per diem basis, to all patients (since it is relative weights rather than absolute costs that are being considered for evaluating compression).

The CMGs™ most impacted by averaging operating room supply costs are shown in Table 4. It is clear that those procedures that required minimal, or less than average, operating room supplies, like CMG™ 90—external and middle ear procedures, and CMG™ 52—retinal procedures, had their cost weight overestimated, whereas joint replacement procedures with high prosthesis costs are underestimated. The reason CMG™ 85—mastoid procedures is on this list is because this CMG includes cochlear implant cases (prosthesis cost approximately $30,000).

CONCLUSIONS

This study has shown that common variations in case costing methodology can have a pervasive and material impact on

Table 4
Top Case-Mix Groups™ Impacted, by Averaging or Supply Costs Simulation

Case-Mix Group™	Description	CIHI RIW	Overestimation of Cost Weight
			Percent
090	EXTERNAL AND MIDDLE EAR PROCEDURES (MNRH)	0.4857	12.3
052	RETINAL PROCEDURES	0.6081	11.9
428	BREAST PROCEDURES EX BIOPSY & LOCAL EXCISION W/O MALIG	0.8112	11.2
055	LENS INSERTION (MNRH)	0.5813	10.8
083	RECONSTRUCTIVE ENT PROCEDURES	1.4188	10.7
375	MINOR UPPER EXTREMITY PROCEDURES	0.6325	10.5
479	THYROID PROCEDURES	0.7778	9.7
078	CLEFT LIP AND PALATE REPAIR	0.8837	9.7
429	TOTAL MASTECTOMY FOR BREAST MALIGNANCY	0.8949	9.5
			Underestimation of Cost Weight
891	VASCULAR REPAIR	2.5745	-5.9
176	CARDIAC VALVE REPLACEMENT W HEART PUMP & CARDIAC CATH	8.6456	-7.1
612	ECTOPIC PREGNANCY WITH MAJOR PROCEDURES	0.7065	-7.7
887	VASCULAR BYPASS SURGERY	2.6196	-8.9
177	CARDIAC VALVE REPLACEMENT W HEART PUMP W/O CARDIAC CATH	5.5727	-10.5
317	LAPAROSCOPIC CHOLECYSTECTOMY	0.8706	-10.7
351	JOINT REPLACEMENT FOR TRAUMA	3.1703	-13.4
352	HIP REPLACEMENT	2.4031	-20.2
354	KNEE REPLACEMENT	2.3050	-24.8
085	MASTOID PROCEDURES	1.7690	-67.5

NOTES: CIHI is the Canadian Institute for Health Information. RIW resource intensity weights.

SOURCE: London Health Sciences Center: Original case cost data.

derivative case-mix cost weights. Results indicate that cost weight compression in the order of 16.2 to 39.6 percent can impact from 21.7 to 67.3 percent of cases in a teaching hospital with a diverse case mix such as LHSC.

It is also noteworthy that the foregoing simulations do not necessarily represent the worst case scenario for cost weight compression. Additional compression will arise from other common case costing methods where precision has been compromised. For example, drug costs may not be itemized, but rather aggregated with ward nursing cost and distributed to individual patients on a per diem basis. Or laboratory and diagnostic imaging costs may be based on the average cost per test or exam rather than on test-specific or exam-specific costs. Further imprecision and compression will also result if separate allocation bases are not used for labor (time-dependant) and supply and equipment depreciation (time-independent) for cost distribution to these individual tests and exams. It must also be acknowledged that case costing systems can only provide an estimate of true costs and that all case costing systems inevitably rely on some levels of averaging. Consequently, this means that the precision of cost weights is inversely related to the level of averaging or use of standard costs that is implicit in any costing methodology.

The study results also show that hospital funding systems which are based on compressed cost weights will be biased against hospitals with an asymmetrical case mix, that is, hospitals with a disproportionate share of high complexity/high-cost weight cases. In Ontario the funding rate calculation includes a hospital-specific Tertiary adjustment to (ostensibly) compensate for cost weight compression. Tertiary-weighted cases (i.e., CMGs™ defined by a combination of above-average cost weight, above-average referral rate, and low number of provider hospitals for that CMG™) as a percent of total hospital weighted cases (times a factor which is based on a multivariate

Table 5

Top Case-Mix Groups™ Impacted, by Combination Simulation

Case-Mix Group™	Description	CIHI RIW	Overestimation of Cost Weight
			Percent
114	SORE THROAT (MNRH)	0.3500	30.0
055	LENS INSERTION (MNRH)	0.5813	26.4
050	ORBITAL PROCEDURES	0.6207	25.9
052	RETINAL PROCEDURES	0.6081	25.2
090	EXTERNAL AND MIDDLE EAR PROCEDURES (MNRH)	0.4857	25.1
479	THYROID PROCEDURES	0.7778	22.0
596	MISCELLANEOUS GYNECOLOGICAL DIAGNOSES (MNRH)	0.3326	22.0
289	INFLAMMATORY BOWEL DISEASE	0.9825	21.7
051	OTHER INTRAOCULAR PROCEDURES	0.6579	21.6
325	PANCREAS DISEASES EXCEPT MALIGNANCY	0.9486	20.8
512	OTHER TRANSURETHRAL OR BIOPSY PROCEDURES (MNRH)	0.5700	19.9
510	TRANSURETHRAL PROSTATECTOMY	0.7426	19.8
428	BREAST PROCEDURES EX BIOPSY & LOCAL EXCISION W/O MALIG	0.8112	19.7
115	MISCELLANEOUS ENT DIAGNOSES (MNRH)	0.4756	19.3
			Underestimation of Cost Weight
776	SCHIZOPHRENIA & OTH PSYCHOTIC DISORD W/O ECT W AXIS III DIAG	2.7426	-14.4
650	TRACHEOSTOMY AND GASTROSTOMY PROCEDURES FOR TRAUMA	14.9369	-15.9
351	JOINT REPLACEMENT FOR TRAUMA	3.1703	-18.5
040	TRACHEOSTOMY AND GASTROSTOMY PROCEDURES	11.8266	-18.9
772	DEMENTIA WITH OR WITHOUT DELIRIUM WITH AXIS III DIAGNOSIS	2.6634	-19.8
786	DISRUPTIVE BEHAVIOUR DISORDERS	2.3897	-21.1
352	HIP REPLACEMENT	2.4031	-21.6
354	KNEE REPLACEMENT	2.3050	-25.0
022	SEIZURE AND HEADACHE	0.6017	-30.3
779	DISSOCIATIVE DISORDERS	0.8079	-36.3
085	MASTOID PROCEDURES	1.7690	-65.0

NOTES: CIHI is the Canadian Institute for Health Information. RIW resource intensity weights.

SOURCE: London Health Sciences Center: Original case cost data.

regression analysis of provincial-wide hospital cost per weighted case data), is used to calculate funding adjustments. For LHSC this tertiary case-mix funding adjustment represented 17.5 percent of total costs. Although this figure cannot be directly compared to the compression figures it is nevertheless another indication of the apparent materiality of cost weight compression as it relates to hospital funding policy.

Internationally, countries have adopted a variety of costing methodologies to suit their capacity and needs. Germany used top-down cost allocation for developing its first patient grouping cost weights (Schepers et al., 2003). Australia collects both top down and activity-based costing in its National Hospital Cost Data Collection (Mazevska, 2002) for developing cost weights while Malaysia uses a combination of top down and activity-based costing (Aljunid, 2003). Top-down methods, however, are all reliant on case-mix-group-specific component cost weights (also called service weights) or ratios (e.g., for nursing, labs, radiology, etc.) for allocating hospital total departmental costs to individual patients. These component cost weights can, in turn, only be derived from an original bottom up cost dataset that is available from hospitals with activity-based costing systems (or hospital charge data from other countries). Consequently, top-down derived cost weights will be no less compressed than the activity-based costing cost weights on which they are ultimately based.

The degree of cost weight compression evident for the nursing workload simulation is particularly relevant to U.S. DRG weight determinations which are (generally) based on hospital charge data. The other two simulations need to be interpreted with much more caution and may not be particularly relevant to U.S. charge-based cost weight estimations since missing support department costs and averaging operating room supply costs are not generally problems in systems with patient-level charges for itemized hospital services. For this reason, the results of the operating room supply-averaging simulation, indicating that orthopedic and cardiac surgery cost weights, for example, are significantly compressed, may be misleading when considered in the U.S. context. In fact, current U.S. cost weights for these types of cases may be antithetical to our study results insofar as peculiarities of charging practices of U.S. hospitals for joint replacement and cardiac bypass surgery cases may well have led to the overestimation, rather than underestimation, of these DRG cost weights. In addition, if there have been higher rates of increase over time in charges of selected services (especially medical devices compared to nursing) this would lead to still further overestimation (hyper-decompression) of cost weights based on charge data.

It is also readily apparent from our simulations that the relative importance of the nursing per diem issue or the averaging of operating room supply costs depends on the relative proportion of total cost accounted for by theses services. Hence, the CMGs™ most impacted (i.e., both over and underestimated) by the nursing per diem simulation were those with the greatest proportion of nursing to total case cost and, concomitantly, the lowest proportion of operating room and ancillary costs (e.g., psychiatric and some medical CMGs™). Our study results, then, are relevant internationally only to the extent that patterns of care and cost proportions are comparable to those in a Canadian hospital. That said, it should also be noted that internationally many, if not most, countries use cost modeling, in the absence of actual national case cost data, to estimate their DRG case-mix cost weights. Cost modeling distributes total hospital departmental costs (e.g., nursing) to individual DRGs based on service weights. These service weights are generally based on U.S. DRG cost weight ratios (i.e., ratio of nursing costs, laboratory costs, radiology costs, etc., to total costs). In other words, many countries, when they estimate their own national DRG cost weights, have already tacitly assumed that U.S. clinical practice patterns and U.S. case charge distribution ratios are similar to their own practice patterns and actual case cost distribution ratios.

However, our results do suggest that previous U.S. studies that concluded that cost-based weights are marginally more compressed than charge-based weights (Lave, 1985: Cotterill, Bobula, and Connerton, 1986; Thorpe, Cretin, and Keeler, 1988; Carter and Farley, 1992) may also be somewhat misleading. The term cost based really refers to grossly (i.e., as in across-the-board) discounted charges. That is, average cost-to-charge ratios (CCRs) are applied to all departmental charges (and single, hospital-wide, routine nursing average per diem and single special care unit average per diem cost values are also used in the cost weight calculation). Such calculations, relying on gross averages, may be producing distorted cost estimates.

First, it has been widely acknowledged that charges, even CCR-discounted charges, are not necessarily good proxies for actual (albeit estimated) costs. Second, the application of an average departmental cost-to-charge ratio is also problematic mathematically, and may in itself cause (and explain) the additional compression being observed in the resultant cost-based weights. That is, discounting both a $20 charge and a $60 charge (a charge difference of $40) by

25-percent, in order to estimate costs of $15 and $45, respectively (a cost difference of only $30), will result in a 25- percent (i.e., [$40 - $30]/$40) compression of estimated cost. So, the observation that cost-based weights are marginally more compressed than charge-based weights then, may be nothing more than an artifact of the CCR calculation methodology itself.

What, then, are the implications of our study as it pertains to MedPAC's objective to improve payment accuracy by employing cost instead of charge data? CIHI's analysis of RIW cost weight changes in 2001, when Canada switched from Maryland charge data to Canadian cost data, showed significant reduction in cost weight compression (Benoit, Sken, and Mitchell, 2000: Sutherland et al., 2001). If, however, by "…basing the DRG relative weights on the estimated costs…", MedPAC intends to employ cost-to-charge ratios to estimate costs, the resultant cost weights will likely be less, not more, accurate than current DRG charge-based weights. At the same time, there do not appear to be any alternative datasets or methods for estimating actual U.S. DRG costs. And it also appears unlikely that a U.S. case costing dataset will ever emerge. U.S. hospitals, even if they have invested in case costing systems, are unlikely, for competitive reasons, to divulge their estimated costs. An alternative might be to consider mining international (i.e., Canada, Australia, and Sweden) case cost datasets to determine if they can provide insights that can be applied to the improvement in the accuracy of DRG cost weights.

In summary, the current study would suggest: (1) that using any average values (either nursing per diems or CCRs) in the calculation/estimation of case costs can result in significant cost weight compression, and (2) there may actually be a significant degree of latent compression in current U.S. DRG cost weights (with no obvious facile alternatives for remediation in the absence of actual case cost data).

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